Industrial Solid Waste Management for Better Green Supply Chain: Barriers and Motivation

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***Abstract*—Moving towards green supply chain activity requires an effective waste management that is applicable and efficient for all industries. The aim of this paper is to find out the barriers and the motivation of the manufacturing companies to implement solid waste management. Barriers are found includes lack of technique and technologies, lack of policy enforcement and responsibility and insufficient of awareness and knowledge. Motivation that led the manufacturing companies to implement solid waste management through encouragement of government, encouragement of non-government organization and socio-psychological incentive. A number of databases in fields such as sociology, social sciences, psychology, and economics were used to acquire literatures on the topic. The findings of the paper include the types of factors that motivate and demotivate the manufacturing companies to implement industrial solid waste management effectively. The paper ends with recommendations on future research on how these factors will help manufacturing companies to implement industrial solid waste management effectively and future research for better environment.**

***Keywords*—solid waste, barriers, motivation, waste management**

I. INTRODUCTION

The increase of solid waste is a big problem faced by global. This was due to the increase of the population of Malaysia at the rate of 2.4% or 600, 000 people on yearly basis. This also led to an increase in Malaysian industry to fulfill the needs and the waste of the Malaysia population. According to Jalil (2010), solid waste produced from both industrial and household sector in the capital of Malaysia was 3500 metric ton each day [1].

Solid waste can be split into eight categories which are imported solid waste, commercial waste, garden waste, construction and demolition waste, household waste, industrial waste, institutional solid waste, public solid waste and solid waste may be prescribed from time to time [2]. This proves that the industry is also one of the major contributors to the increasing of solid waste in Malaysia. The quantities and the type of industrial waste are usually depend on the characteristic of industrial activity.

This problem will be worsened if solid waste management is not well-managed because it can cause pollution, resource degradation and health problem for humans and animals. The example of environmental impacts are, the loss of recreational facilities, damage or loss of biodiversity; air, water, land and noise pollution, loss of aesthetic landscapes and scenery and burst hazards [2]. To solve this problem, the government implements a landfill and recycling method of solid waste generated. However, the landfill method also has problems and weakness because it is difficult to be practiced and cause environmental pollution. Meanwhile, recycling method is difficult to implement because not all waste can be recycled. This problem has led into the implementation of solid waste management in manufacturing

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companies to help the government effort to reduce the industrial solid waste. This system needs an effective waste management within the company in order to minimize and to control the solid waste generated by manufacturing companies themselves.

Malaysia has experienced the increasing of solid waste. In 2012, Malaysians generated 33,000 tonnes of solid waste daily and will exceed the projected production of 30,000 tonnes by 2020 [3]. According to Moh and Abd Manaf (2014), the overall waste composition in Malaysia is monopolized by municipal solid waste (MSW) (64%), followed by industrial waste (25%), commercial waste (8%) and construction waste (3%) [3]. In Asia, the management of waste material needs an immediate attention especially in countries such as China, Malaysia and South Korea which have been categorized as emerging industrialized country [4]. This can prove that the industrial waste is one of the contributors that increased waste in Malaysia. Malaysia as a developing country, also face problem from the aspect of technology, manpower, land scarcity and lack of infrastructure to accommodate and to manage the increase of waste [4]. This problem is expected to increase in a few years while corresponding to the economic development, population growth, and urbanization as Malaysia's population is expected to achieve 33.4 million by the year 2020 and 37.4 million by the year 2030 [3].

To solve this problem, the government uses landfill as the method of waste disposal (80% usage) in Malaysia [3]. The solid wastes will send to landfill sites for disposal are the mixture of the industrial and the municipal solid wastes which include plastic, textile, iron, food wastes, metal, glass, rubber, cardboard, paper, aluminum and miscellaneous based on Agamuthu & Fauziah, 2011; Desa et al., 2011; Saeed et al., 2009) [1]. Ali (2009) saw that Malaysia has about 289 landfills out of which only 7 are sanitary landfills. There are 95% of waste is sent to landfill sites and most of these were dumped in sites that are open areas without proper control [1]. However, this method also has its own problems and weakness such as difficulty to be implemented and can cause environmental pollution. This landfill method brings various environmental problem such as leachate, groundwater, contamination, the potential release of toxic gas and odor [3]. Most landfills in Malaysia are in bad conditions and operated without proper protective measures, such as lining systems, leachate treatment and gas venting (Ismail & Manaf, 2013) [3].

Purpose of Inquiry and Inquiry Questions

This paper is intended to identify and to understand the factors that motivate and demotivate the manufacturing companies in implementing industrial solid waste management effectively. The answer to the inquiry questions will be based on an extended review and analysis of literature.

Significance of the Inquiry

This conceptual paper is significant because it will explore a number of factors that affect the manufacturing companies' attitude towards solid waste management. This paper will examine those factors and make recommendations for future research

II. LITERATURE REVIEW

A. *Waste*

Williams (1998) stated that waste is an unavoidable by-product of human activities [5]. Waste refers to any material or product that has been considered useless by the owner and needs to be discarded or thrown away [6]. In addition, waste is also a disposition item that is spoilt, degraded, expended or simply no longer useful to the owner [7]. Waste in accordance to 'Basel Convention' is a material of object disposed or intended for disposal or is required by the disposal of national laws. Wastes may be generated during the extraction of raw material, the processing of raw materials to middle or final product and other human activities (Faizal, Fatimah & Armi, 2014).

B. *Solid Waste Management*

In the context of this research, the researcher only focuses on solid waste management in manufacturing companies.

Solid waste management is associated with the control of production, storage, collection, transfer and transport and finally disposal of various solid waste [5]. Based on Kreith (2008), solid waste management refers to the process of production, storage, source separation, collection, transportation, processing, recycling and disposal of both organic and inorganic solid waste [6]. Tchobanoglous et al (1993) categorize that there are two types of solid waste which are solid waste organic and solid waste inorganic. Organic solid waste is a waste material that can be burned and decomposed such as waste of food, paper and cardboard (Afrizal, 2016). Whereas, inorganic solid waste is non-combustible and decomposed by microorganisms because it has a long and complex carbon chain (Afrizal, 2016) such as glass, iron, and aluminium. Other than that, this material also can be reconditioned, reused and recycled (Afrizal, 2016). The objective of solid waste management is to improve waste minimization strategy and control [8]. According to Birute (2012), solid waste is any organic or inorganic materials generated from various human activities which have been considered unwanted or useless therefore disposed to be treated or untreated [6].

Solid waste management is defined as a combination of the method of production, storage, collection, transfer, transportation, processing, and disposal of solid waste based on the general health, economic, engineering, aesthetic and environmental considerations (Afrizal, 2016). There are three methods of waste disposal management commonly practiced in many countries such as the open garbage disposal method, sanitary disposal, and disposal using incinerator. (Afrizal, 2016). The aims of solid waste management are to protect human health and to improve the quality of the environment through surveillance, management, and planning (Afrizal, 2016). Solid waste is a material that becomes surplus or excess of unwanted materials (Anuar, 2016).

C. Industrial Solid Waste

The term "Industrial waste" refer to all waste arising from the industrial operation or derived from manufacturing processes [9]. Industrial waste is any solid waste generated from industrial activities [2]. The composition and characteristic of industrial waste depend on industrial activities [1]. The industrial waste can be classified into two group which are the hazardous industrial waste and industrial solid waste [1]. The composition of industrial solid waste is paper, plastic, packaging and bulky waste with increasing trend toward waste generation (Ngoc & Schnitzer, 2009) [1]. However, this study only focuses on industrial solid waste.

D. Barriers of Solid Waste Management

Barriers of solid waste management are the obstacles faced by the manufacturing companies to build an effective solid waste management. Solid waste management is implemented to reduce waste management costs, to reduce carbon footprint, waste minimization and to achieve environmental compliance. The barriers of practicing waste minimization by industrial sector are lack of awareness, knowledge, and information, old technologies and governance and economic factors [1]. In the context of this study has four barriers of solid waste management which are lack of technique and technologies, lack of policy enforcement and responsibility and insufficient of awareness and knowledge.

1) Lack of Technique and Technologies.

According to Ilomaki and Melanen (2001) in their study found that, waste minimization in small medium enterprises exposed that technology is an efficient tool which offers a great opportunity in waste minimization [1]. Many research and development of technology have been carried out to reduce waste while at the same time bring benefit to the environment and human (Faizal, Fatimah & Armi, 2014). However, most countries who implement the solid waste management are at the local government level (Afrizal, 2016). Additionally, most of the technologies produced will require a large area, costly and is not flexible such as material recovery facilities (MRF), derivative fuel, incinerator composting, solid waste disposal center, carbonization and food waste

crushers (Faizal, Fatimah & Armi, 2014). This is because manufacturing companies' lack of technique and technology to implement the effective solid waste management in their company.

2) Lack of Policy Enforcement and Responsibility

That same study also points out of the lack of enforcement of the waste management legislation as a major barrier for an effective and a sustainable waste management in the developing world [10]. This lack of enforcement policies and laws are major institutional issue that greatly affords to the mismanagement of solid waste in the developing countries [10]. In addition, there are weaknesses in law enforcement and management and administration regarding solid waste management among communities (Afrizal, 2016). This has proven that Malaysia is also experiencing this problem. Waste was dumped along the roads and in the outskirts of towns where many of the poorest lived, or citizens who did not comply with the program and there was no agency to enforce the regulations [10].

Moreover, there is no legal action was taken on the culprit because throw away rubbish in inappropriate areas. This has caused the culprit will regardless the warning issued by the government. Regulations are needs for the industry practitioners to follow and apply in their way of waste management [11]. However, it is a challenge to generate a holistic solid waste management system integrated, cost-effective, sustainable, and acceptable to the community, with accentuation on environmental conservation and technology selection [11].

3) Inadequate Financial Source

Many industry practitioners were averse to join the activity of embracing waste minimization simply because it meant higher costs (Mills et al, 1999). This has made it difficult for manufacturing companies to implement effective solid waste management systems. Kelly (1976) said that the deterioration of the solid waste management system was due to insufficient financial resources (Afrizal, 2016).

It was further noted that fiscal aspect played a fundamental role in waste minimization implementation and the devoid of financial support is a fundamental barrier to waste management (Agamuthu & Fauziah, 2011). Funds provided by the company should be sufficient of financial to implement the solid waste management system. However, if the company following a suitable practice of waste minimization, cost saving by any company can be achieved (Bates & Phillip, 1999).

4) Insufficient Awareness and Knowledge of Solid Waste Management

The barriers to executing solid waste management in manufacturing companies is an insufficient awareness and knowledge of waste management. According to Lumbreras & Fernández, (2014) the need to improve public awareness of, and community participation in, waste management has been widely admitted by researchers as necessary to create sustainable waste systems and to promote environmental citizenship amongst community members [10]. In the context of research, need to improve awareness of manufacturing companies to participate in waste management as necessary to create a sustainable waste system. The problem that always happens in Malaysia communities is regarded as solid waste management only responsibility of Local Authorities and will cause them do not take seriously and care about hygiene, health, and safety (Afrizal, 2016). This has led an irresponsible attitude towards the problem of solid waste disposal (Afrizal, 2016). This also is supported by Aini (2002) exhibit that, in order to overcome the solid waste crisis, the "conscience of the individual needs to be raised through environmental awareness and concern inculcation of sustainable consumption practices and education on waste management"[10].

This problem also will cause lack of knowledge about solid waste management. It was further noted that environmental knowledge plays a basic role in forming waste management behavior (Barr, 2017). Through this weakness, the companies will have the problem where lack of trained personnel in manufacturing companies to build effective solid waste management systems.

If the company has only information related to solid waste management but lacking knowledge may not be effective in making changes to the company. Other than that, the lack of interest in the environment brings to the culture of non-participation of communities in decision-making processes [10]. This will make manufacturing companies difficult to involve or participate in solid waste management programs. The program should give information to industry on the way that can influence the effectiveness of solid waste management program. According to Desa et al, (2011) suggested that campaign for awareness played an effective role in raising the awareness and help change attitudes and perception toward solid waste management. This action can give some exposure to manufacturing companies about solid waste management.

E. Motivation of Solid Waste Management

According to George R. Terry (1977), motivation is defined as a desire in an individual to encourage them to act (Ali & Syamsir, 2013). Next, to Muhammad Ali Embi (2001 and 2003), motivation is also defined as an individual internal process that will become stimulation for the emergence of an action that leads to the desired action. According to Abdul Rahman Aziz (1997), states motivation in an impetus can give the individual extra energy and spirit to take steps and endeavour to achieve the desired (Jamaludin, 2016). Motivation is complicated because it is influenced by many factors, whether it comes from within of an individual (internal factor) or from the outside of the individual (external factor) (Ali & Syamsir, 2013). In the context of this research, it has led the manufacturing companies to implement solid waste management in their company through encouragement of government, encouragement of non-government organization and socio-psychological incentive. Most industries interest to reduce the problem of solid waste that generate in their area (Afrizal, 2016).

1) Encouragement of Government

Government plays an important role in encouraging companies to implement solid waste management systems in their company. The government is the enforcement, regulatory and policy implementer (Anuar, 2016).There are several policies, campaign and plan that has been introduced by the government in order to reduce the generation of solid waste in Malaysia, which are National Environmental Policy, Cleanliness Campaign, Action plan of Beautiful and Clean Malaysia (ABC Plan), Recycle policy, Privatization of Solid waste management policy, National Recycling Campaign, National Strategic Plan dan National Solid waste management policy (Afrizal, 2016).

The Privatization Policy of Solid Waste Management Policy was introduced in 1994. This policy aims to improve the quality of services and to provide a better solid waste management facility. Subsequently, the National Environment Policy is a form of government rule to manage the environmental issue including solid waste. There are several strategies under this policy such as to enhance the education and the public awareness; to intensify the role of the media, to organize national inventory and audit, conduct and implement land-use planning establish monitoring and monitoring systems, promote to use the modern technology, shape accounting systems of natural resources, creating an integrated plan and creating government agency support (Afrizal, 2016).

Besides, the government had introduced the Cleanliness Campaign in 1983. The purpose of this program is to create a clean environment and to maintain the physical environment in order to be inherited by future generations. According to Afrizal (2016), the government has also executed the National Recycle Campaign introduced in 2000 by the Department of Environment and Ministry of Urban Wellbeing, Housing and Local Government (KPKT). The purpose of a campaign is to recycle the used item in the first phase throughout peninsular Malaysia (Afrizal, 2016). According to Suhana (2003), measures undertaken by the government are intended to ensure that all Malaysian people will practice to collect used goods. The used item will be sent to the collection center for reprocessing (Afrizal, 2016).

Next, ABC Plan was formed by Ministry of Housing and Local Government in 1988. The

aim of the plan is to establish a uniform solid waste management system, costs effective, acceptable of solid waste management and also not pollute the environment by 2020. Then, the government introduced the National Strategic Plan in 2005 for solid waste management forms the basis for solid waste policy and practice in Peninsular Malaysia until 2020. The aims of this plan are redressed policies, strategies and action plans in the solid waste management systems. In addition, this plan also reviews the existing solid waste management, the legal and regulatory management institutions and improvise the infrastructure (Afrizal, 2016).

Through the building policy, the government will monitor the industry to implement effective solid waste management using proper and appropriate procedures and do not negatively impact to the environment and customer. This caused the government to urge manufacturing companies to implement effective solid waste management systems.

2) Encouragement of Non-government Organization

The motivation of non-government organization is related to humanitarian problems and an attention for development (Afrizal, 2016). They act to help the community ability to play an active role in managing solid waste (Afrizal, 2016). This can increase public awareness to solve solid waste problems (Afrizal, 2016). The industrial area is the focus area that needs to avoid the presence of solid waste pollution in that area (Afrizal, 2016). This can bring an uncomfortable feeling to their customers and also affect their business. This can encourage manufacturing companies to implement solid waste management. The non-government organizations always undertake programs or activities involving communities and businesses. The planned activities need to be arranged according to the interests and the suitability of the objectives and the individual involved (Jamaludin, 2016). McClelland (1978) states that a person will succeed in enhancing his inner motivation when the individual understands and actively involved in motivational activities or programs (Jamaludin, 2016).

3) Socio-psychological Incentive

Next, socio-psychological incentive also is one way to encourage manufacturing companies to implement the effective solid waste management systems. According to Milea (2009), the socio-psychological incentive is referred to as incentive that changes attitudes and behavior through disseminating information, persuasion by relating waste minimization to the achievement of valued goals and making use of social pressure among others [10]. The most frequently used method of disseminating information by using media. Media is a means of disseminating information and news to the whole country. There are three types of media which are print medium, broadcast medium, and the internet. Media also serves to raise the awareness of manufacturing companies regarding solid waste management in their company. Other than that, Mosler (2008) found out that mass media's involvement through the use of advertisement and campaigns geared towards recycling and reusing the product, was seen as a useful encouragement to public participation in waste management informational sessions and activities [10].

III. METHODOLOGY

This conceptual paper is based solely on reviews has research analysis and data from the literature. Bibliometric is a study of journals has been produced worldwide. This method was to provide illustration of the trends of journals waste management and manufacturing produced in 2010 until 2017. This data was collected from the Scopus system. Where, the researcher uses key of title "Waste Management" AND key of title "Manufacturing". This journals is limited to 2010 until 2017 and as much as 391 journals that has been produced within 8 years. The type of document produced was article and written in English. This bibliometric contains five section which are quantity of journals by the year, distribution of author by country, ranking of author, ranking of university and most influenced source of journals. This study only takes the top 10 ranking in each section. Based on Fig. 1. shows production of journals related with waste management and manufacturing is unstable.

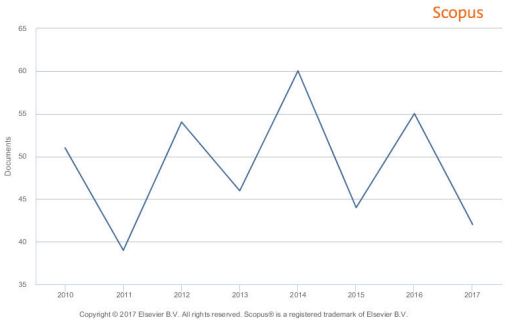

Fig. 1. Quantity of Journals by the Year

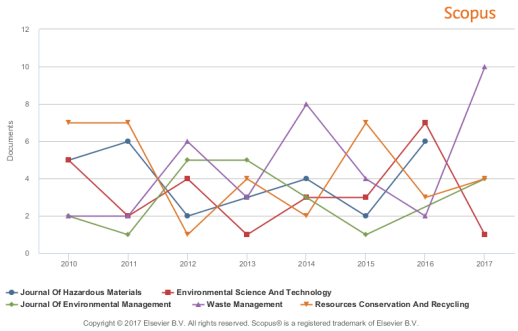

Fig. 2. Most influenced source of journals

Based on the Fig. 1., quantity of journals by the year from 2010 until 2017 are 391 journals produced. This graph was collected based on research about waste management and manufacturing. Starting on 2010, total of journal 51 journals has been produced. But in 2011, the graph declined to 39 journals. In 2012, journals increase of 15 journals which is 54 journals has been produced on that year. The quantity of journals has been produced in 2013 decrease to 46 journals from the total 54 in the year 2012. The journals has been produced in 2014 was 60 journals with the increment of 14 journals. However, the quantity of journals was decrease again in 2015 which is 44 journals has been produced on that year. Journals has been produced in 2016 was increase from 44 journals in 2015 to 55 journals. In 2017, 42 journals has been produced with amount of descent as much as 13 journals.

TABLE I. MOST INFLUENCED SOURCE OF JOURNALS

Type of Source	Quantity of Journals
Waste Management	37
Resources Conservation and Recycling	35
Journal of Hazardous Materials	28
Environmental Science and Technology	26
Journal of Environmental Management	21
International Journal of Life Cycle Assessment	20
Science of The Total Environment	20
Water Science and Technology	16
Bioresource Technology	13
Chemosphere	13

There are 10 types of source that contribute to the quantity of journals has been produced. The published journals relates to "Waste Management" AND "Manufacturing" has been produced from 2010 to 2017. Based on the TABLE I, the waste management is one of the highest source contributor which is 37 journals has been produced. The Fig. 2., shows in 2017 the waste management source is the highest quantity of journals produced amount of 10 journals has been successfully produced, whereas minimum production of journals is in 2010, 2011 and 2016 with a total of 2 journals.

Then followed by Resource Conservation and Recycling with a total of 35 journals within 8 years. The highest quantity of journals produced was 7 journals in 2010, 2011 and 2015. However, in 2012 there were only 1 journals produced. The third ranking of source is Journal of Hazardous material because 28 journals has been produced. In 2011 and 2016, the highest production of these journals is 6 journals. While, in 2012 and 2015 where the lowest journals has been produced which is only 2 journals.

Next, the environmental science and the technology occupies fourth position with total of 26 journals within 8 years. The highest production of this journal was 7 journals in 2016. However, in 2013 and 2017 it has produced a small amount of quantity of journals which is one journals. In addition, the Journals of Environmental Management produced with total of 21 journals. The highest production of these journals is 5 journals in 2012 and 2013. But, in 2011 and 2015 only one journals released.

Furthermore, International journals of life cycle Assessment and Science of the Total

Technology produced same quantity of journals which is 20 journals. Whereby, Water Science and Technology produced 16 journals within 8 years from 2010 until 2017. Lastly, journals related to Biosource and Chemosphere also produced same quantity of journals which 13 journals.

A. Data Collection and Data Sources for Future Research

This is a conceptual paper that is based solely on a review of literature on the topic of barriers and motivation of manufacturing companies to implement industrial solid waste management. For future research a qualitative study would be conducted to obtain data on the manufacturing companies' barriers and motivation of manufacturing companies to implement industrial solid waste management. A qualitative method would be used because qualitative research is often associated with an interpretive philosophy. It is interpretive because researchers need to make sense of the subjective and socially constructed meanings expressed about phenomena being studied (Saunder et al, 2016). the researcher needs to understand deeply about this study and the researcher will also gain accurate and strong data. Moreover, the researcher will give respondent some opportunity to discuss this topic in depth. From qualitative method, the researcher also can increase understanding of this topic. The sample could be an individual who knows about the company solid waste management in order to reduce the error of data collection.

IV. CONCLUSION

In conclusion, the findings led us to draw conclusions about what factors affect the motivation of the companies to implement solid waste management and make recommendations for future research. As in previous discussion, solid waste management in Malaysia has been controlled by Local Authorities. Where undertake collection and processing solid waste generated by the communities. There are companies that implement solid waste management because it can reduce costs and increases the company profits. However, not all company in Malaysia carry out their own solid waste management because of several factors such as lack of technologies and technique, lack of enforcement and regulation, inadequate financial source and insufficient awareness and knowledge of solid waste management. There also have a motivation that can be applied to ensure solid waste management can be developed by all manufacturing companies in Malaysia which are a socio-psychological incentive, encouragement of government and encouragement of non-government.

It is obvious that no single factor is responsible for solid waste management. We live in a society where we are also responsible for waste management. In order to have better solid waste management, policy makers must access all the factors that impact perceptions and get those factors to promote social responsibility in solid waste management.

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